

NEW ANT-LYCAENID ASSOCIATIONS AND BIOLOGICAL DATA FOR SOME AUSTRALIAN BUTTERFLIES (LEPIDOPTERA: LYCAENIDAE)

ROD EASTWOOD¹, MICHAEL F. BRABY^{2,3}, DAVID J. LOHMAN⁴ and
ALAN KING⁵

¹*Museum of Comparative Zoology, Harvard University, 26 Oxford St., Cambridge MA-02138, USA*

²*Biodiversity Conservation Division, Department of Natural Resources, Environment and the Arts, PO Box 496, Palmerston, NT 0831*

³*School of Botany and Zoology, The Australian National University, Canberra, ACT 0200*

⁴*Department of Biological Sciences, National University of Singapore, 14 Science Drive 4, Singapore 117543*

⁵*PO Box 1302, GPO Townsville, Qld 4810*

Abstract

Records of 61 ant-lycaenid associations and other ecological data are tabulated for 27 Australian species of Lycaenidae. Thirty-one of the ant-lycaenid associations and four larval food plant records are new. Ant-lycaenid records are discussed in further detail for 11 lycaenid species from the genera *Paralucia* Waterhouse & Turner, *Hypochrysops* C. & R. Felder, *Ogyris* Angas, *Hypolycaena* C. & R. Felder, *Deudorix* Hewitson, *Nesolycaena* Waterhouse & Turner, *Catopyrops* Toxopeus and *Theclinesithes* Rober.

Introduction

The early stages of many lycaenid butterflies associate with ants. These associations vary considerably among species, ranging from non-specific facultative to highly specific obligate myrmecophily or even parasitism (myrmecophagy) by the butterfly larvae (Pierce *et al.* 2002). Evolutionary factors that may have promoted this variation in ant attendance levels are not well understood. However, differences in the intensity of ant-lycaenid associations, among butterfly taxa whose evolutionary relationships are known, can be contrasted in a phylogenetic framework to address questions such as whether facultative associations evolved before obligate associations and whether parasitism is derived from mutualism.

By measuring population genetic structure in pairs of lycaenid sister species that differ in the degree to which they rely on ants as mutualistic partners, it might be possible to infer the role that ants play in lycaenid demographics and, hence, their role in lycaenid diversification (*e.g.* Eastwood *et al.* 2006). Underpinning these broad research objectives is the need for complete and accurate biological and ecological data; thus it is important to publish such baseline records. This paper builds on earlier works documenting ant-lycaenid associations (Common and Waterhouse 1981, Eastwood and Fraser 1999, Schmidt 2002), as well as providing new biological data for several Australian lycaenid species.

Methods and observations

Observations of lycaenid biology and the collection of their associated ants were undertaken opportunistically by us and several other lepidopterists between 1991 and 2007. Voucher specimens of ants identified by A. Andersen are deposited at CSIRO Sustainable Ecosystems, Darwin (TERC); *Camponotus* Mayr identified by A. McArthur are deposited in the South Australian Museum, Adelaide (SAM); *Polyrhachis* Smith identified by R. Kohout are held at the Queensland Museum, Brisbane (QM); and all remaining species are deposited in the Museum of Comparative Zoology at Harvard University, USA (MCZ). Butterfly nomenclature largely follows Braby (2000), with modifications to comply with the International Code of Zoological Nomenclature. Ant nomenclature follows Shattuck (1999), with additional nomenclature from R. Kohout (pers. comm.).

In total, 61 ant-lycaenid associations, of which 31 are new, are listed in Table 1, together with four new food plant associations and incidental observations. Ant-lycaenid associations which duplicate previously published records are included for spatial and temporal information only. Additional biological and ecological data are discussed below for selected lycaenid species.

Paralucia pyrodiscus (Doubleday)

P. pyrodiscus has been recorded only in association with *Notoncus* Emery ants (Common and Waterhouse 1972, Eastwood and Fraser 1999). Our records bring the number of attendant species of *Notoncus* to four, namely *N. capitatus* Forel, *N. ectatommoides* (Forel), *N. gilberti* Forel and *N. enormis* Szabó. The closely related taxa *Paralucia aurifera* (Blanchard) and *P. spinifera* Edwards & Common both associate with *Anonychomyrma* Donisthorpe ants; thus it is possible that the specificity of ant association within the *Paralucia* Waterhouse & Turner lineage has contributed to their diversification.

Hypochrysops digglesii (Hewitson)

This obligate myrmecophile has been recorded only in association with *Crematogaster* Lund ants (Common and Waterhouse 1972, Eastwood and Fraser 1999, Schmidt 2002). During a population explosion at Indooroopilly in 2003, two different *Crematogaster* species were recorded in attendance. The specificity of ant association for *H. digglesii* appears to be constrained at the generic level (*i.e.* to *Crematogaster*).

Hypochrysops polycletus rovena Druce

The attendant ant recorded here, *Iridomyrmex sanguineus* Forel, is a large 'meat ant' in the *purpureus* species group (Andersen 2000). In addition to attending *H. p. rovena* larvae on the food plant, the ants constructed shelters with sand and bark particles for mature larvae and pupae at the base of the plant. Although the behaviour of shelter building for butterfly larvae is not

Table 1. Ant attendance records and biological data for lycaenid butterfly larvae and pupae in Australia.

Lycaenid species	Attendant ant	Voucher Repository	Date and location	Notes
<i>Lucia limbaria</i> (Swainson)	<i>Iridomyrmex rufoniger</i> (Lowne)	AA145 (MCZ)	22.ii.2005 Darlington Point, NSW (34°34'02"S, 146°00'12"E)	LFP <i>Oxalis perennans</i>
<i>Acrodipsas cuprea</i> (Sands)	<i>Crematogaster</i> sp. near <i>laeviceps</i> * Smith	(TERC)	19.x.2002 Burrewarra Point, NSW	LFP <i>Acacia mearnsii</i> Numerous ants associated with eggs on trunks of mature trees
<i>Paralucia aurifera</i> (Blanchard)	<i>Anoilychomyrma</i> sp. (<i>nitidiceps</i> group) (E.André)	MFB06 (TERC)	19.vii.2004 Tallaganda NP, 9 km E of Hoskinstown, NSW (35°24'S, 149°32'E)	LFP <i>Bursaria spinosa</i> Numerous ants attending early stages at base of small plants
<i>P. pyrodiscus</i> (Doubleday)	<i>Notoncus enormis</i> *	00.045 (MCZ)	25.ix.2001 1.4 km N of Isla Gorge, Qld	-
	<i>Notoncus</i> sp. (<i>enormis</i> group)*	(TERC)	15.i.2005 Kowen Escarpment, 8 km NNE Queanbeyan, ACT, 650 m (35°17'26"S, 149°15'28"E)	LFP <i>Bursaria spinosa</i> Numerous ants attending early stages at base of small plants
<i>Hypochrysops digglesii</i> (Hewitson)	<i>Crematogaster</i> spp.	00.033 (MCZ)	23.iv.2003 Indooroopilly, Qld	-
<i>H. polycletus rovena</i> Druce	<i>Iridomyrmex sanguineus</i> *	00.050 (MCZ)	5.xii.1999 Mt Stuart, Townsville, Qld	LFP <i>Rhyssoterys timorensis</i>
	<i>Iridomyrmex</i> sp.	00.052 (MCZ)	7.xii.1999 Townsville, Qld	LFP <i>Rhyssoterys timorensis</i>
<i>H. apelles apelles</i> (Fabricius)	<i>Crematogaster</i> sp. 9 group C	(TERC)	03.vi.2006 Buffalo Creek, Leanyer Swamp, Darwin, NT (12°21'19"S, 130°54'20"E)	LFP <i>Lummitzera racemosa</i> Numerous ants attending three late instar larvae
<i>H. ignita erythrinus</i> (Waterhouse & Lyell)	<i>Papyrius</i> sp. 1 (<i>nitidus</i> group) (Mayr)	(TERC)	15.iii.2006 Litchfield Nat Park, NT (13°02'S, 130°55'E)	LFP <i>Planchonia careya</i> Numerous ants attending three larvae on small regenerating plants
<i>Ogyris abrota</i> (Westwood)	<i>Crematogaster</i> sp.	MFB07 (MCZ)	13.vii.1997 Mt Mugga Mugga, ACT	LFP <i>Muellerina eucalyptoides</i>
	<i>Crematogaster</i> sp.	GF01 (MCZ)	26.ii.2006 Tocumwal, NSW	-

Table 1. Continued.

Lycaenid species	Attendant ant	Voucher Repository	Date and location	Notes
<i>O. oroetes</i> (Hewitson) 'Arid form'	<i>Anonychomyrma</i> sp. Donisthorpe	00.036 (MCZ)	16.x.1999 11 km S of Amelup, Stirling Ra, WA	Attending pupa
	<i>Crematogaster</i> sp. <i>?longiceps</i> * Forel	(TERC)	14.x.2005 Finke River, 6 km S Hermannsburg, Hermannsburg Aboriginal L.T., NT; 560 m (23°59'28"S, 132°46'32"E)	LFP <i>Amyema miquelii</i> Three ants each attending two late instar larvae/prepupae under loose bark at base of <i>Eucalyptus</i> <i>camaldulensis</i>
	<i>Crematogaster</i> sp. <i>?longiceps</i> *	(TERC)	30.vi.2006 Trephina Gorge Nat Park, East Macdonnell Ranges, NT; 550 m (23°31'41"S, 134°22'48"E)	LFP <i>Amyema miquelii</i> One or two ants attending a few larvae on <i>Eucalyptus</i> with numerous clumps of mistletoe; most larvae not attended.
<i>O. oroetes</i> <i>oroetes</i> (Hewitson)	<i>Technomyrmex</i> sp. Mayr	00.046 (MCZ)	17.viii.1999 Brisbane, Qld	-
	<i>Tetramorium</i> <i>simillimum</i> * (Smith)	00.032 (MCZ)	8.vi.2000 Capalaba, Qld	Ants attending prepupa
<i>O. olane</i> (Hewitson)	<i>Crematogaster</i> sp.	00.035 (MCZ)	27.i.2001 Mt McKenzie, NSW	-
	<i>Podomyrma</i> <i>adelaidae</i> * (Smith)	RE-02- A188 (MCZ)	26.xi.2002 10 km W of Bordertown, SA	-
<i>O. amaryllis</i> <i>meridionalis</i> (Bethune- Baker)	<i>Iridomyrmex</i> sp.	00.034 (MCZ)	27.xi.1999 Kalbarri, WA	-
<i>O. amaryllis</i> <i>amata</i> (Waterhouse)	<i>Crematogaster</i> sp. <i>laeviceps</i> ? group Smith	(TERC)	vii.1997 Murrumbidgee River, Uriara Crossing, ACT	LFP <i>Amyema cambagei</i> A few ants attending larva in hollow twig of mistletoe parasitising <i>Casuarina</i> <i>cunninghamii</i> ; most larvae not tended.
<i>Hypolycaena</i> <i>phorbas</i> <i>phorbas</i> (Fabricius)	<i>Paratrechina</i> sp.*	00.051 (MCZ)	15.xii.2000 Upper Ross River, 14 km SW of Townsville, Qld	LFP <i>Clerodendrum</i> sp.
	<i>Tetramorium</i> <i>bicarinarum</i> * (Nylander)	00.047 (MCZ)	4.iii.2000 Aitkenvale, Townsville, Qld	LFP <i>Clerodendrum</i> <i>longiflorum</i> †

Table 1. Continued.

Lycaenid species	Attendant ant	Voucher Repository	Date and location	Notes
<i>Deudorix diovis</i> Hewitson	<i>Paratrechina</i> sp.	00.026-29 (MCZ)	14.xi.2000 East Ballina, NSW	LFP <i>Cupaniopsis</i> sp.
	<i>Crematogaster</i> sp.	00.025 (MCZ)	13.xi.2000 Broken Head, NSW	LFP <i>Cupaniopsis</i> sp.
	<i>Pheidole variabilis</i> * Mayr	No voucher	Brisbane	Attending pupa
	<i>P. megacephala</i> (Fabricius)	00.031 (MCZ)	14.xi.2000 East Ballina, NSW	LFP <i>Cupaniopsis</i> sp.
	<i>Rhytidoponera metallica</i> * (Smith)	00.030 (MCZ)	14.xi.2000 East Ballina, NSW	LFP <i>Cupaniopsis</i> sp.
<i>D. similis dalyensis</i> (Le Souëf & Tindale)	<i>Crematogaster</i> Group A sp. 3 (CSIRO)*	(TERC)	2.vi.2007 Lee Point, Casuarina Coastal Reserve, NT; (12°19'54"S, 130°53'40"E)	LFP <i>Strychnos lucida</i> 1-2 ants associated with pupae inside fruits.
<i>Candalides absimilis</i> (Felder)	<i>Technomyrmex</i> sp.	RE-03- B118 (MCZ)	17.i.2003 Chapel Hill, Brisbane, Qld	Ants attending larvae
<i>Nesolycaena urumelia</i> (Tindale)	<i>Polyrhachis gab</i> * Forel	(TERC)	15.iv.2006 Litchfield Nat Park, NT; 190 m (13°07'32"S, 130°48'11"E)	LFP <i>Boronia lanceolata</i> Two ants attending one late instar larva; most larvae not attended
	<i>Monomorium</i> sp. 8 (<i>carinatum</i> group)* Heterick	(TERC)	15.iv.2006 Litchfield Nat Park, NT; 190 m (13°07'32"S, 130°48'11"E)	LFP <i>Boronia lanceolata</i> Four ants attending one early instar larva; most larvae not attended
<i>Nacaduba berenice berenice</i> (Herrich- Schäffer)	<i>Polyrhachis</i> (<i>Chariomyrma</i>) <i>aurea</i> * Mayr	00.037 (QM)	19.xii.2000 Fisherman's Island, Brisbane, Qld	Attending larvae
<i>Catopyrops florinda halys</i> Waterhouse	<i>Iridomyrmex</i> sp.*	99.036 (MCZ)	9.iii.1999 Griffith Uni. Nathan Campus, Qld	LFP <i>Trema tomentosa</i>
	<i>Paratrechina</i> sp.*	99.001 (MCZ)	15.xii.1998 Griffith Uni. Nathan Campus, Qld	LFP <i>Trema tomentosa</i>
	<i>Paratrechina</i> sp.*	00.023 (MCZ)	26.iv.2000 Macgregor, Brisbane, Qld	LFP <i>Pipturis</i> sp.
	<i>Tetramorium bicarinatum</i> *	00.024 (MCZ)	26.iv.2000 Macgregor, Brisbane, Qld	LFP <i>Pipturis</i> sp.

Table 1. Continued.

Lycaenid species	Attendant ant	Voucher Repository	Date and location	Notes
<i>Theclinesthes onycha onycha</i> (Hewitson)	<i>Polyrhachis (Hagiomyrma) lydiae</i> * Forel	GF02 (QM)	5.iv.2006 Chapel Hill, Qld	-
<i>T. onycha capricornia</i> Sibatani & Grund	<i>Monomorium</i> sp.*	00.039 (MCZ)	13.xii.1991 Cardwell, Qld	LFP <i>Cycas media</i>
<i>T. miskini miskini</i> (Lucas)	<i>Iridomyrmex</i> sp.	RE-02-A475 (MCZ)	13.i.2003 Edungalba Turnoff, Qld	-
	<i>Iridomyrmex reburrus</i> * Shattuck	(TERC)	15.iv.2006 Litchfield Nat Park, NT (13°07'32"S, 130°48'11"E) 190 m	LFP <i>Acacia difficilis</i> † Numerous ants attending six prepupae/pupae
	<i>Iridomyrmex reburrus</i> *	(TERC)	17.ii.2007 Black Point, Cobourg Peninsula, NT (11.15515°S, 132.14391°E)	LFP <i>Acacia auriculiformis</i> Numerous ants on small plant with eggs; a few ants attending 1 larva
	<i>Iridomyrmex reburrus</i> *	(TERC)	14.i.2007 Berry Springs, NT (12.67576°S, 131.00876°E)	LFP <i>Eucalyptus</i> Numerous ants attending larvae and pupae on small regenerating plant
	<i>Iridomyrmex</i> sp. 21 (<i>gracilis</i> group)*	(TERC)	14.i.2007 Berry Springs, NT (12.67576°S, 131.00876°E)	LFP <i>Eucalyptus</i> Numerous ants attending larvae and pupae on small regenerating plant
	<i>Iridomyrmex</i> sp. (<i>mattiroloi</i> group)* Emery	(TERC)	3.ii.2007 Cobourg Peninsula, NT (11.15015°S, 132.16125°E)	LFP <i>Acacia holosericea</i> A few ants attending larvae
	<i>Iridomyrmex</i> sp. (<i>anceps</i> group) (Roger)	(TERC)	28.i.2007 Muirella Park, Kakadu NP, NT (12.85462°S, 132.75468°E)	LFP <i>Acacia holosericea</i> A few ants attending one early instar larva and two prepupae
<i>T. miskini eucalypti</i> Sibatani & Grund	<i>Iridomyrmex</i> sp.	00.040 (MCZ)	2.xii.1991 Cardwell, Qld	LFP <i>Corymbia clarksoniana</i> Seedling about 20 cm high (record based on female ovipositing on plant that was covered in swarms of small black ants)

Table 1. Continued.

Lycaenid species	Attendant ant	Voucher Repository	Date and location	Notes
<i>T. miskini eucalypti</i> Sibatani & Grund (cont.)	<i>Iridomyrmex</i> sp.	00.042 (MCZ)	4.iii.1992 Cardwell, Qld	LFP <i>Acacia crassiparpa</i>
	<i>Camponotus maculatus humilior</i> * Forel	00.049 (SAM)	7.i.2001 Mt Stuart, Townsville, Qld	LFP <i>Xylomelum scottianum</i> [†]
	<i>Opisthopsis haddoni</i> * Emery	00.048 (MCZ)	7.i.2001 Mt Stuart, Townsville, Qld	LFP <i>Xylomelum scottianum</i> [†]
<i>T. albocincta</i> (Waterhouse)	<i>Iridomyrmex</i> sp.	00.043 (MCZ)	22.xii.1997 Eastern Lookout, Wyperfield NP, Vic.	LFP <i>Adriana tomentosa</i>
<i>T. serpentata serpentata</i> (Herrich-Schäffer)	<i>Iridomyrmex</i> sp.	00.038 (MCZ)	7.iii.1991 Rainbow, Vic.	LFP <i>Rhagodia</i> sp.
	<i>Iridomyrmex</i> sp.	00.044 (MCZ)	25.i.1999 Wapengo Lagoon, 11 km NNE of Tathra, NSW	LFP <i>Atriplex</i> sp. A few ants attending larvae
<i>T. sulphitius</i> (Miskin)	<i>Iridomyrmex</i> sp.*	00.041 (MCZ)	24.viii.1991 Cleveland Bay Beach, Townsville, Qld	LFP <i>Suaeda australis</i>
<i>Lampides boeticus</i> (Linnaeus)	<i>Dolichoderus scrobiculatus</i> * (Mayr)	MFB09 (TERC)	27.iii.1992 Ilbilbie, Qld	LFP <i>Indigofera pratensis</i> flowers [†]
	<i>Iridomyrmex</i> sp. (<i>suchieri</i> group)* Forel	(TERC)	29.iv.1992 Campaspe River, 17.5 km NE of Pentland, Qld	LFP <i>Crotalaria goreensis</i> flowers
<i>Famegana alsulus alsulus</i> (Herrich-Schäffer)	<i>Iridomyrmex ?septentrionalis</i> * Forel	MFB04 (TERC)	27.iii.1992 Ilbilbie, Qld	LFP <i>Indigofera pratensis</i> flowers
	<i>Iridomyrmex gracilis</i> group* (Lowne)	MFB03 (TERC)	27.ii.1992 Cardwell, Qld	LFP <i>Indigofera pratensis</i> flowers
<i>Freyeria putli putli</i> (Kollar)	<i>Opisthopsis haddoni</i> * <i>Tetramorium deceptum</i> * Bolton	MFB02 (TERC) MFB08 (TERC)	17.ii.1992 Townsville, Qld 6.ii.1992 Townsville, Qld	LFP <i>Indigofera hirsuta</i> LFP <i>Indigofera hirsuta</i>

LFP = larval food plant; * = new ant-lycaenid association; [†] = new larval food plant record; letters in brackets indicate the repository for ant specimens (see Observations).

uncommon among attendant ants (e.g. *Camponotus* with *Ogyris genoveva* (Hewitson) and *Papyrius* Shattuck with *Hypochrysops ignita* (Leach)), such behaviour has not been recorded previously in the *purpureus* species group. *H. p. rovena* is likely to be an obligate myrmecophile, as are most species of *Hypochrysops* C. & R. Felder whose life histories are known. However, it appears to have non-specific ant associates, being recorded in the wild with at least three ant species from two subfamilies (Muller 1998, Eastwood and Fraser 1999, Table 1).

Ogyris oroetes (Hewitson)

The two new ant association records listed here (Table 1) bring the total number of attendant ant species for this facultatively ant-associated butterfly species to 13 (Eastwood and Fraser 1999, Schmidt 2002, Table 1).

Hypolycaena phorbas phorbas (Fabricius)

H. phorbas is considered to be an obligate myrmecophile that is typically tended by the green tree ant *Oecophylla smaragdina* (Fabricius) (Common and Waterhouse 1981). The atypical ant associates (*Tetramorium* Mayr and *Paratrechina* Motschulsky spp.) recorded here were found tending *H. phorbas* at two locations near Townsville, Queensland. In addition to attending the butterfly larvae, both species of ants were found feeding on phloem exuding from leaf edges damaged by larval feeding by the butterfly. Although *Clerodendrum* species (Verbenaceae) are known larval food plants for *H. phorbas* (Common and Waterhouse 1981), *C. longiflorum* Decne. is previously unrecorded.

Deudorix diovis Hewitson

Larvae are not commonly attended by ants because they feed inside the fruit of their food plant. The ants recorded here were attending prepupal larvae and pupae attached to the base of food plants or to accumulated debris in forks or other convenient locations. Schmidt (2002) recorded at least nine ant species associated with larvae and pupae of *D. diovis* in Brisbane, Queensland and the two additional records here confirm the non-specificity of ant-associates for this lycaenid. While non-specific ant association is regarded as a defining characteristic of facultative myrmecophiles (Fiedler 1996), ant-association during the prepupal and pupal phase may be obligatory for *D. diovis* (also see Eastwood *et al.* 2005).

Deudorix smilis dalyensis (Le Souëf & Tindale)

Two ant species, *Crematogaster* sp. (Myrmicinae) and *Oecophylla smaragdina* (Formicinae) are now recorded in association with the early stages of this lycaenid. The butterfly larvae and pupae are usually found without ants, but when ants are present their numbers are low (Eastwood and Fraser 1999). Unlike *D. diovis*, described above, *D. smilis dalyensis* pupates inside fruit of the larval food plant and it is likely to have only a facultative association with ants.

Nesolycaena urumelia (Tindale)

Both of the ant species recorded in attendance are new records (Table 1). This is another facultative myrmecophile: larvae are not usually tended by ants, ant-association is non-specific and attendance levels, when present, are low.

Catopyrops florinda halys Waterhouse

This subspecies is found commonly around Brisbane, Queensland, in autumn. Ants rarely attend early instar larvae, which rest under young leaves of the larval food plant alongside the midrib, but later instars are occasionally attended. At Macgregor, Brisbane, larvae were attended by two ant species (*Paratrechina* sp. and *Tetramorium* sp.) as they fed on two different branches of a cultivated *Pipturis* sp. tree (Urticaceae). Similarly at Griffith University (Nathan Campus), Brisbane, several *Paratrechina* and a single *Iridomyrmex* Mayr species, most likely *I. gracilis* (Lowne), were found in attendance on a small *Trema tomentosa* (Roxb.) Hara (Ulmaceae).

Theclinesstes onycha (Hewitson)

The two ant associations listed for this species in Table 1 were each recorded in attendance with two subspecies of *T. onycha*, namely *T. onycha capricornia* Sibatani & Grund in northern Queensland and *T. onycha onycha* in southeastern Queensland. These two new records bring the total number of attendant ants to nine (Eastwood and Fraser 1999, Table 1) and confirm the non-specific nature of their ant associations in contrast with the larval food plant specificity of the two butterfly subspecies, which feed exclusively on Cycadaceae in the north and on Zamiaceae in the south (Braby 2000).

Theclinesstes miskini (Lucas)

Two new larval food plants for this species are recorded here together with two new ant associations (Table 1). This brings the total number of food plants for this taxon to 29 from five families (Braby 2000) and attendant ants to at least 12 species from eight genera (Eastwood and Fraser 1999). Non-specific ant association appears to be typical for *Theclinesstes* Rober species, all of which are regarded as facultative myrmecophiles. However, all other *Theclinesstes* species or subspecies are ecologically specialised in terms of their food plant range, as are most facultative myrmecophiles (Pierce and Elgar 1985). The wide larval food plant range coupled with non-specificity of ant associates in *T. miskini* is unusual and may indicate some evolutionary instability in the taxon.

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